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Geometric aspects and meteorological applications of Nambu mechanics: The motion of three point vortices in the plane

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The classical theory of point vortices was introduced by Helmholtz in 1858 and twenty years later rewritten by Kirchhoff using Hamilton's canonical equations of motion. Point vortex dynamics is characterized by the circulation leading to a physical discretisation of a continuous vorticity field. In this presentation it will be shown that the dynamics of three point vortices in the plane can also also be described by non-canonical Nambu mechanics.
Nambu mechanics in a three dimensional phase space is based on two conserved quantities. The representation of these two conserved quantities as surfaces in the phase space leads to a geometric application of Nambu mechanics. One surface is given by the total energy, the other surface is determined by the relative angular momentum. The topological structure of the relative angular momentum surface represents a hyperboloid, a cone or an ellipse in the phase space. Both conserved quantities depend on the intervortical distances which build the three dimensional phase space. The intersection of the energy surface and the relative angular momentum surface defines the trajectory of three point vortices in the phase space. Examples of periodic motion and the collapse motion of three point vortices in the plane will be discussed.
Contracting high and two low pressure areas to point vortices leads to to a meteorological application of point vortex dynamics. As an example of three point vortex motion an omega blocking of the westerly flow as a special persistent large-scale weather situation will be presented. ERA-Interim data were used to determine the circulation and the observed motion will be compared to analytical results.